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NATIONAL DAM SAFETY PROGRAM. LAKE HOLLENBECK DAM (MO 40050), UP--ETC(U)
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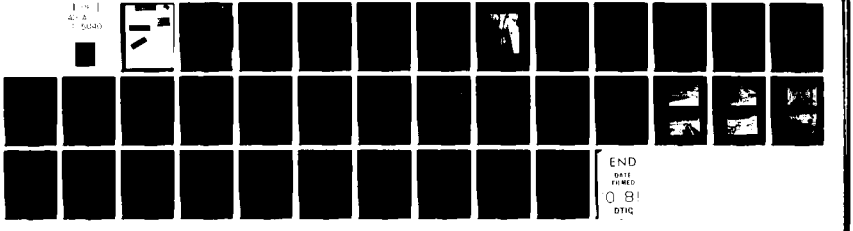

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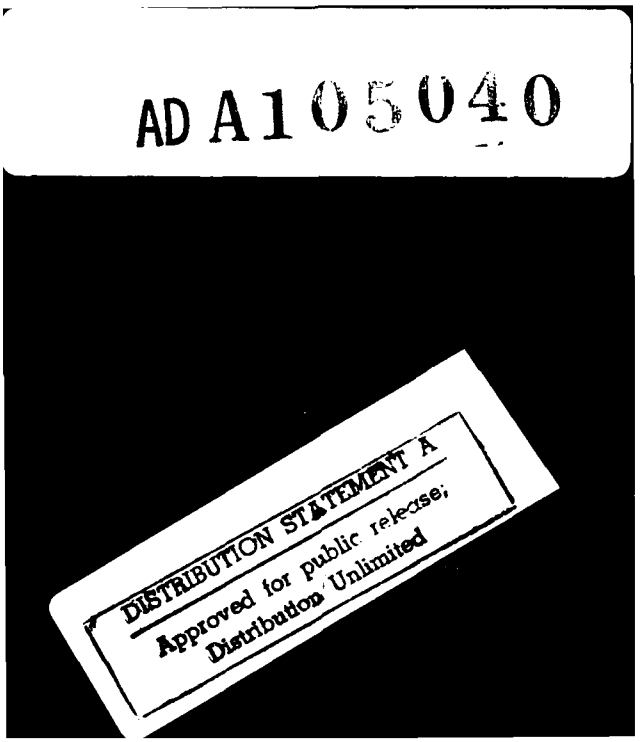
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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER
2. GOVT ACCESSION NO. AD-A105040
3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
Phase I Dam Inspection Report
National Dam Safety Program
Lake Hollenbeck Dam (MO 40050)
Cape Girardeau County, Missouri

5. TYPE OF REPORT & PERIOD COVERED
Final Report.

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
Kenneth Balk and Associates, Inc.

8. CONTRACT OR GRANT NUMBER(s)
DACW43-78-C-0169

9. PERFORMING ORGANIZATION NAME AND ADDRESS
U.S. Army Engineer District, St. Louis
Dam Inventory and Inspection Section, LMSED-PD
210 Tucker Blvd., North, St. Louis, Mo. 63101

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
U.S. Army Engineer District, St. Louis
Dam Inventory and Inspection Section, LMSED-PD
210 Tucker Blvd., North, St. Louis, Mo. 63101

12. REPORT DATE
November 1978

13. NUMBER OF PAGES
Approximately 35

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
National Dam Safety Program. Lake Hollenbeck Dam (MO 40050), Upper Mississippi - Mississippi - Kaskaskai - St. Louis Basin, Cape Girardeau County, Missouri.

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Lake Hollenbeck Dam (Mo. 40050), Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lake Hollenbeck Dam (Mo. 40050).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood.

2) Overtopping could result in dam failure.

3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED
Chief, Engineering Division — Date 13 MAR 1979

APPROVED BY: SIGNED
Colonel, CE, District Engineer — Date 14 MAR 1979

LAKE HOLLENBECK DAM

CAPE GIRARDEAU COUNTY, MISSOURI

MISSOURI INVENTORY NO. 40050

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY

Kenneth Balk & Associates, Inc.
St. Louis, Missouri
Shannon & Wilson, Inc.
St. Louis, Missouri

PREPARED FOR

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

NOVEMBER, 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Lake Hollenbeck
State Located	Missouri
County Located	Cape Girardeau County
Stream	Tributary To Cape LaCroix Creek
Date of Inspection	September 7, 1978

Lake Hollenbeck Dam, No. 40050 was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U. S. Army, Washington, D.C., with the help of Federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Lake Hollenbeck Dam was visually inspected by an interdisciplinary team of engineers from Kenneth Balk & Associates, Inc. and Shannon & Wilson, Inc. The purpose of the inspection was to make a preliminary assessment of the general condition of the dam with respect to safety in order to determine if, in the opinion of the interdisciplinary team, the dam poses recognizable hazards to human life or property. This assessment is based solely upon data made available and visual evidence observed during the site visit.

To make a complete assessment of the safety of the dam would require detailed studies and engineering analyses beyond the scope of this preliminary assessment.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The estimated damage zone extends approximately five miles downstream of the dam. Within the estimated damage zone are three houses, two mobile homes, one large barn, one farm complex, three highway bridges, and one improved road crossing. This listing does not include the portions of the city of Cape Girardeau, Missouri in the estimated damage zone, including many residences and commercial establishments, a school, a park, and other highways and roads. To determine the complete listing of property which could be affected by failure of Lake Hollenbeck Dam would require detailed downstream flood routing. This effort is beyond the scope of investigations for Phase I Dam Safety Investigations. Lake Hollenbeck Dam is in the intermediate size classification since it is greater than 40 feet high but less than 100 feet high.

The inspection and evaluation indicate that the spillway of Lake Hollenbeck does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Lake Hollenbeck is an intermediate size dam with a high hazard potential, required by the guidelines to pass the PMF. Considering the high hazard potential to loss of life and property downstream of the dam, the outlet facilities of Lake Hollenbeck Dam should be able to pass the PMF without overtopping the dam. However, it was determined that the spillway will only pass approximately 30 percent of the PMF without overtopping the dam.

Since the outlet facilities for Lake Hollenbeck are not capable of passing the PMF without overtopping the dam, the spillway is considered inadequate.

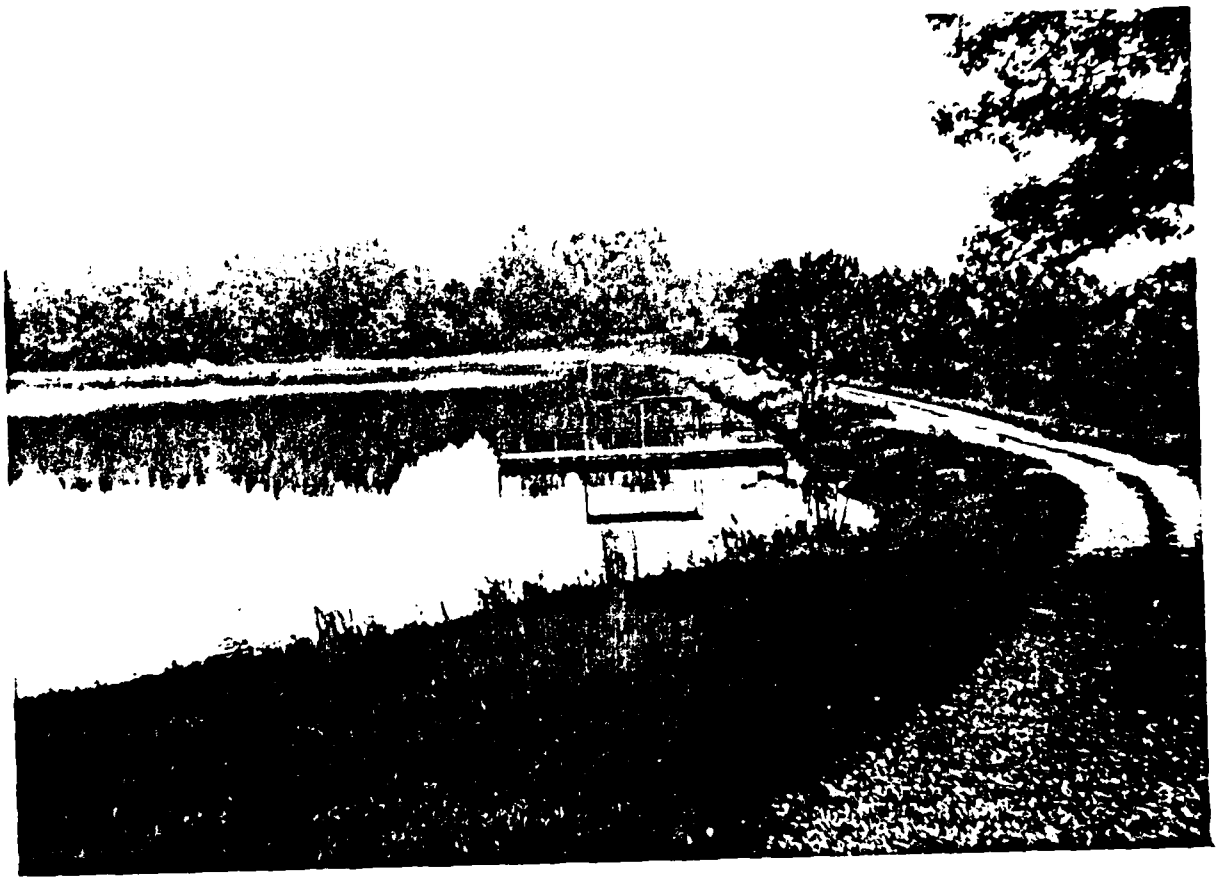
The evaluation of Lake Hollenbeck also indicated that the spillway will pass the 100-year flood; that is, a flood having a 1 percent chance of being equalled or exceeded during any given year.

Deficiencies visually observed by the inspection team were seepage, erosion, and some small trees on the downstream slope. Other deficiencies found were the lack of seepage records, operational records, seepage and stability analyses comparable to the requirements of the Recommended Guidelines, and seismic stability analyses.

It is recommended that action be taken in the near future to correct or control the deficiencies described.

Ervin H. Baumeyer, P.E.
Principal-In-Charge
Kenneth Balk and Associates, Inc.
St. Louis, Missouri

Lutz Kunze, P.E.
Principal Engineer
Shannon & Wilson, Inc.
St. Louis, Missouri



Overview of Lake and Dam

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE HOLLENBECK DAM - ID NO. 40050

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APPENDIX

LIST OF PLATES

LIST OF PHOTOGRAPHS

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Lake Hollenbeck Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon data made available and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure built on a tributary to Cape LaCroix Creek in the southern part of Cape Girardeau County, Missouri. Topography adjacent to the valley is rolling and shown on Plate 1.

(2) The principal spillway consists of a 8' x 3' concrete box culvert located on the right abutment. There is an emergency overflow spillway, essentially consisting of a swale in the road approximately 12.5 feet wide, located on the north side of the lake. No controls for regulating flows were found.

(3) Pertinent physical data are given in paragraph 1.3 below.

b. Location. The dam is located in the southeastern portion of Cape Girardeau County, Missouri, as shown on Plate 2. The lake formed by the dam is on the Missouri-Cape Girardeau County Cape Girardeau quadrangle sheet in the SW 1/4 of Section 15, T31N, R13E.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines refererced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the intermediate size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph c. Based on referenced guidelines, the Corps of Engineers has determined that this dam is in the High Hazard Classification and thus has been selected by the Corps of Engineers for a Phase I inspection.

e. Ownership. It is our understanding that this dam is owned by Girl Scouts of America, Otahki Council, 108 N. Park, Cape Girardeau, Missouri 63701.

f. Purpose of Dam. The dam forms a recreational lake.

g. Design and Construction History. There are no known design plans or construction records. According to information supplied by the Corps of Engineers, the dam was completed in 1960.

h. Normal Operating Procedure. No operating records were found. Outflow passes through uncontrolled spillways. Normal rainfall, spillway discharges, runoff, transpiration, and evaporation all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 177 acres.

b. Discharge at Damsite.

(1) Concrete Box Culvert 84.6 cfs. at maximum pool.

(2) Emergency spillway - 226.1 cfs at maximum pool.

(3) Estimated experienced maximum flood - approximately one foot below top of dam.

c. Elevation (U.S.G.S.)

(1) Top of dam - 492.0±.

(2) Invert of concrete box culvert spillway - 489.0±.

(3) Spillway Crest - 489.0±.

(4) Streambed at Centerline of Dam - 450±.

(5) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 2200 feet ±.

e. Storage (Acre-feet).

(1) Normal - 465.3

(2) Maximum - 552.3

f. Reservoir Surface (Acres).

(1) Top of dam - 31.

(2) Spillway crest - 26.

g. Dam.

(1) Type - earth embankment.

(2) Length - 700 feet.

(3) Height - 42 feet maximum.

(4) Top width - 21 feet.

(5) Side Slopes - (Measured by slope meter/inclinometer in degrees and converted to ratios.)

(a) Downstream - 2.75 H to 1 V.

(b) Upstream - 4.5 H to 1 V to waterline.

(6) Zoning - unknown

(7) Impervious core - unknown

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel. - None.

i. Principal Spillway.

(1) Type - Concrete 8' x 3' box approximately 23 feet in length, with paved apron and wingwalls, length approximately 7 feet, angled at $\pm 30^{0}$ at the upstream end.

(2) Crest elevation - 489.0 U.S.G.S.

j. Emergency Overflow Spillway

(1) Type - Earthen channel, generally trapezoidial in section, approximately 12.5 feet wide with side slopes approximately 4 H. to 1 V.

(2) Invert at lakeside 490.5 (USGS).

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were found to be readily available.

2.2 CONSTRUCTION

The dam was completed in 1960.

2.3 OPERATION

No records of the maximum loading on the dam were available.

2.4 EVALUATION

a. Availability. No engineering or geological data were readily available.

b. Adequacy. No engineering data was made available to make a detailed assessment of the design, construction, and operation. The lack of seepage and stability analyses comparable to the requirements of the Recommended Guidelines is considered a deficiency which should be corrected. An engineer experienced in the design of dams should be retained to perform detailed seepage and stability analyses.

c. Validity. No valid engineering data on design were available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General. A visual inspection of the Lake Hollenbeck Dam was carried out on September 7, 1978. Personnel making the inspection were employees of Kenneth Balk and Associates, Inc. and Shannon and Wilson, Inc. of St. Louis and included civil, geotechnical, and structural engineers and an engineering geologist. Specific observations are discussed below.

B. Dam. The inspection team observed the following at the dam. The dam is an earth embankment with a hard packed earth road running the length of the crest. No detrimental settlement, depressions or cracking was observed along the crest or adjacent to the embankment. Upstream slope erosion protection consists of a cover of grass.

Seepage with accompanying erosion channels was observed along a line approximately 1/3 up from the toe on the downstream slope. The quantity of seepage could not be measured but a small perceptible flow was noted. Small amounts of seepage were also observed along the junction of both the right and left abutment with the embankment.

Erosion channels, ranging from 12 inches deep and 18 inches wide to 2 feet deep and 4 feet wide, were observed on the downstream slope about 1/3 from the crest and toward the right abutment.

Some small trees, brush and cattails are growing on the downstream slope and one medium size tree on the upstream slope near the right abutment. Some small animal burrows were observed on the downstream slope.

The dam has little freeboard, (approximately 3 feet).

C. Appurtenant Structures. The principal spillway, consisting of a concrete box, located at the right or south abutment, and its outlet channel are in good condition. The outlet channel is lined with a sand-cement grout for approximately 30 feet. Spillway discharges would not, in our opinion, endanger the integrity of the dam.

The emergency overflow spillway is located on the north side of the lake and its discharge presents no problem to the dam's integrity.

D. Damsite Geology. No bedrock was exposed at the dam or in the immediate vicinity. The overburden consists of a brown clayey silt, however, the depth of the rock was not determined. The regional geology consists of shales and limestones of the Ordovician series.

E. Reservoir Area. No wave wash, excessive erosion or slides were observed along the shore of the reservoir.

3.2 EVALUATION

The existing conditions found, in our opinion, do not require immediate remedial action, however, the seepage observed along the junction of the abutments with the embankment and on the face of the downstream slope, if left uncontrolled, may adversely affect the stability of the dam. The numerous erosion channels and the few observed animal burrows, if left uncorrected, may also affect the dam's stability. In addition, uncontrolled vegetation is a potential seepage hazard and encourages wild life, which may include burrowing animals.

In the opinion of the inspection team, the services of a professional engineer experienced in the design of dams should be obtained to evaluate the deficiences noted.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

No regulating structure exists at this dam. The lake level is affected by rainfall, runoff, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

No maintenance records of the dam were available. The amount and size of the vegetation on the embankment suggest that maintenance, if any, has not been regular.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

In our opinion, a regular program of vegetation control and maintenance should be initiated. The trees and brush on the dam are deficiences which should be corrected.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. There were no hydraulic and hydrological design data made available.

b. Experience Data. The drainage area and lake surface area are developed from USGS Cape Girardeau Mo. Quadrangle. The spillway and dam layout are from surveys made during the inspection.

c. Visual Observations.

(1) The concrete box spillway and outlet channel are in good condition. The spillway outlet channel is located at the right or south abutment. Spillway discharges, in our opinion, would not endanger the integrity of the dam.

(2) The emergency overflow spillway is located on the north side of the lake and its discharge presents no problem to the dam's integrity.

d. Overtopping Potential. The principal and overflow spillways have been found to be inadequate to pass the Probable Maximum Flood (PMF) without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

For the PMF, the dam would be overtopped to a maximum height of approximately 1.6 feet with a duration of overtopping of approximately 5.8 hours and a maximum discharge rate of 2625 cfs. In our opinion, failure of the dam may be expected to occur as a result of overtopping for this length of time.

The spillways have been found to be adequate to pass a flood of approximately thirty percent (30%) of the PMF.

The spillways have been found to be adequate to pass the 100-year flood, which has a 1% chance of being equalled or exceeded at least once during any given year.

The estimated damage zone extends five miles downstream of the dam. Within the damage zone are three homes, two mobile homes, one large barn, one farm complex, three highway bridges, and one improved road crossing. The floodplain is farmed.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visually observed conditions which can affect the structural stability of this dam have been discussed in Section 3.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam were found except that discussed in Section 1.2.

c. Operating Records. No records were made available at the time of the inspection.

d. Post-Construction Changes. No post-construction changes are known or apparent.

e. Seismic Stability. Lake Hollenbeck Dam is located in Seismic Zone 3. Since no engineering design data was available, an evaluation of the seismic stability of the dam could not be made. An earthquake of the magnitude that can be expected in Seismic Zone 3 may affect the structural stability of a dam of this size.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Corrective measures should be taken for the deficiencies visually observed by the inspection team, i.e. seepage, erosion and growth of trees on the embankment and in the spillway outlet channel. Inadequate spillway capacities are considered a deficiency which should be corrected.

b. Adequacy of Information. No engineering design and construction data was available and the conclusions of this report are based on performance and external visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analysis comparable to the requirements of the recommended guidelines (including seismic analyses) were not available and this is considered a deficiency which should be rectified.

7.2 REMEDIAL MEASURES

a. O&M Procedures. The following O&M procedures are recommended:

(1) Trees and excessive vegetation should be removed from the upstream and downstream slopes.

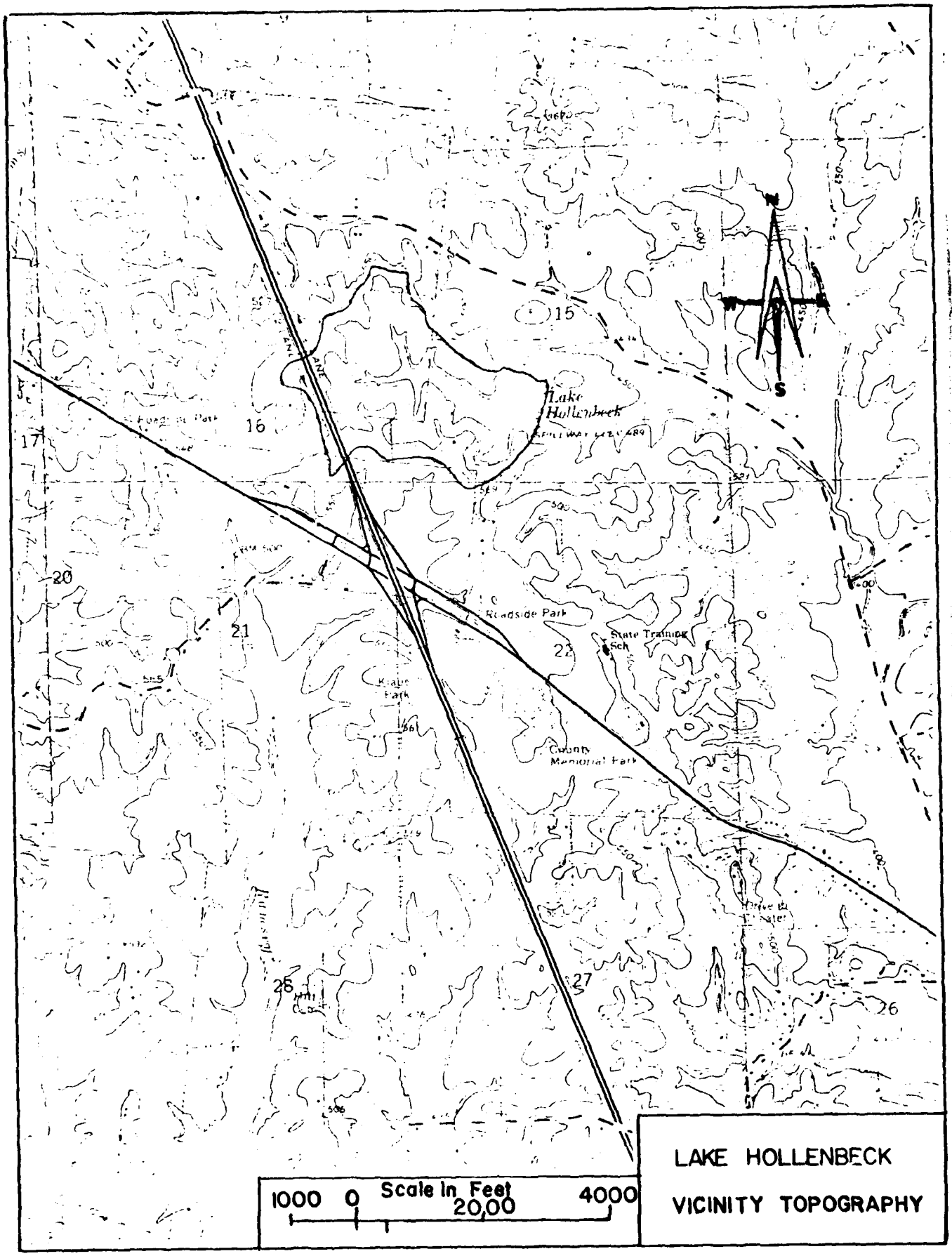
(2) Seepage should be monitored to determine the quantity of flow and sedimentation and it is recommended that corrective measures be designed by an experienced professional engineer based on appropriate analyses.

(3) Erosion channels should be filled and a grass cover planted to prevent recurrence..

(4) Up-to-date records of all future maintenance and repairs should be kept.

(5) Spillway capacity and/or height of dam should be increased to pass 100 percent (100%) of the Probable Maximum Flood.

(6) The dam should be periodically inspected by an engineer experienced in the design and construction of dams.



LAKE HOLLENBECK
VICINITY TOPOGRAPHY

PLATE I

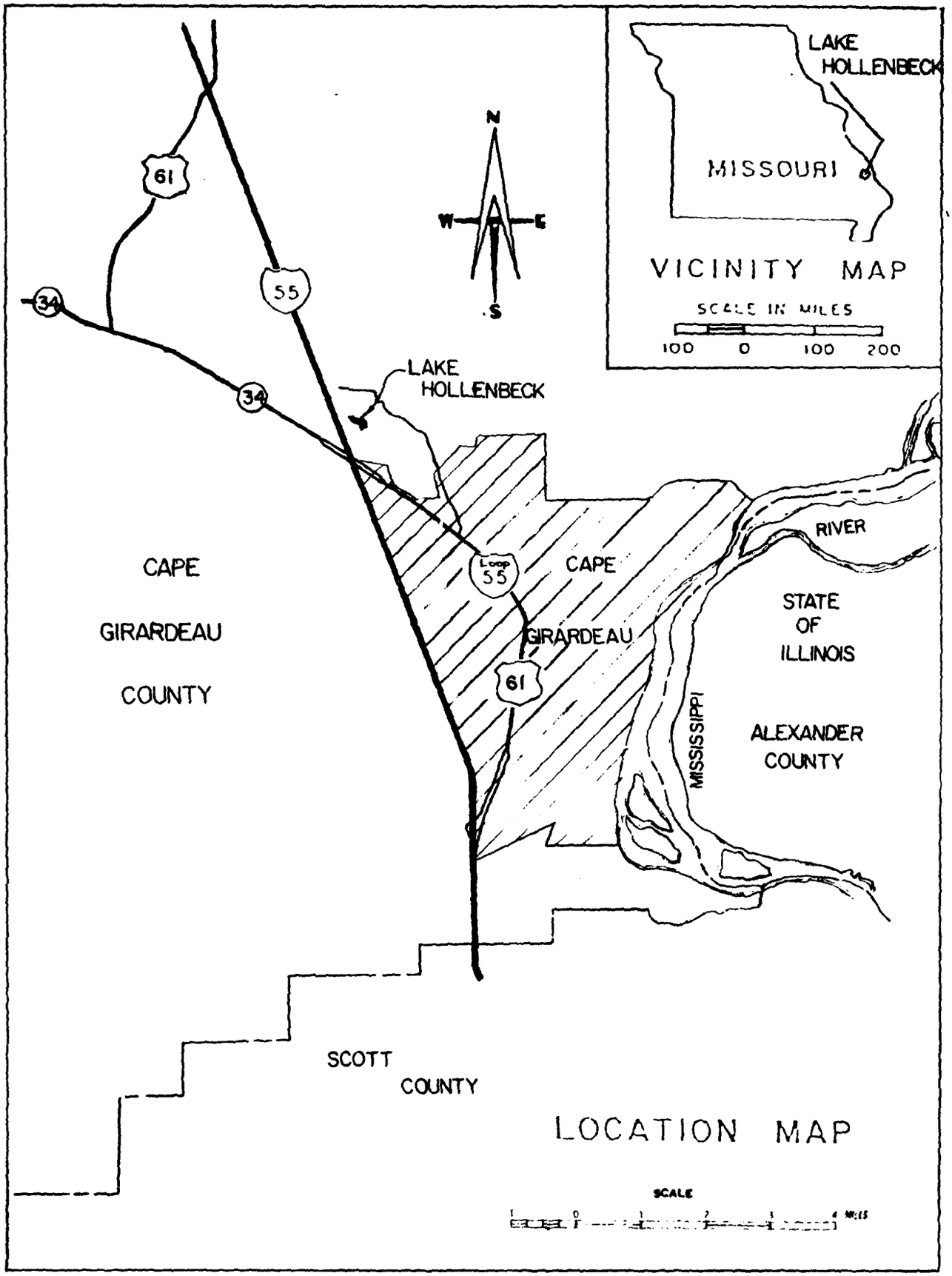
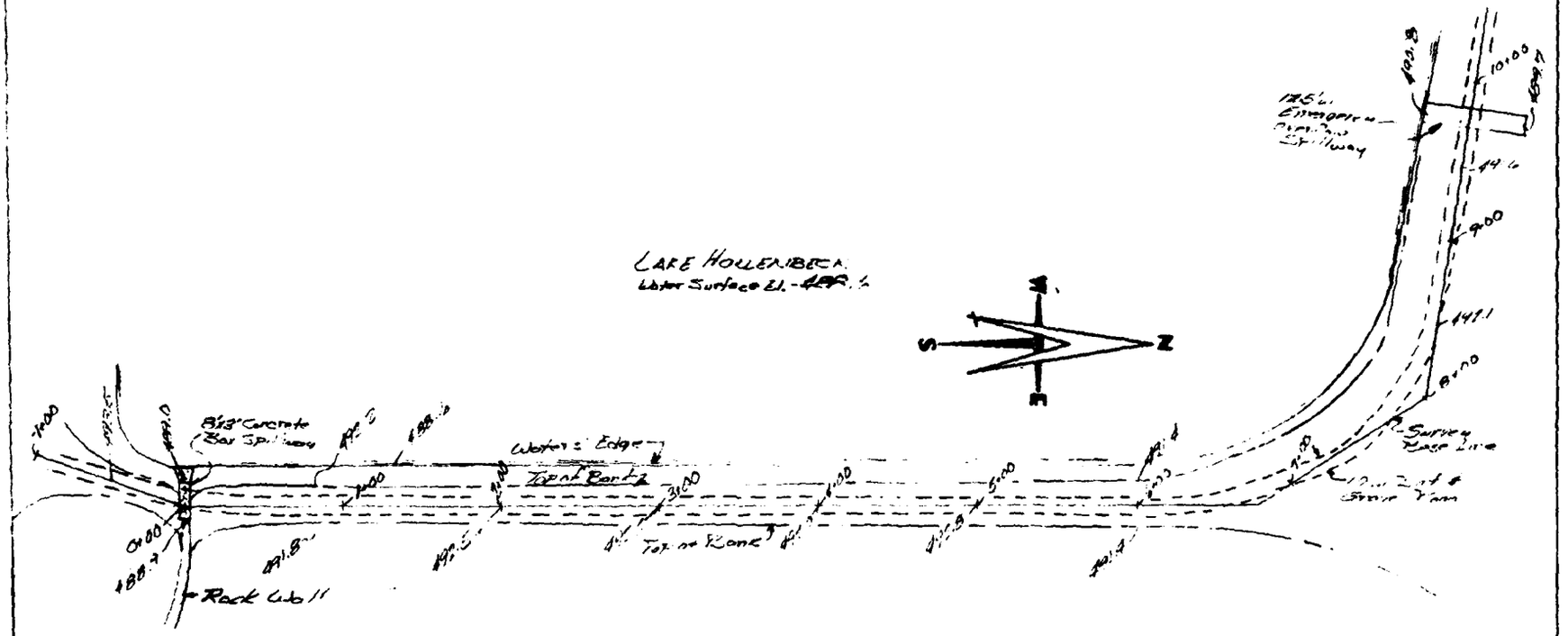

LAKE
HOLLENBECK
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
N
W
E
S
61
55
34
34
LAKE
HOLLENBECK
CAPE
GIRARDEAU
COUNTY
Loop
55
CAPE
GIRARDEAU
61
RIVER
STATE
OF
ILLINOIS
MISSISSIPPI
ALEXANDER
COUNTY
SCOTT
COUNTY
LOCATION MAP
SCALE
0 1 2 3 4 MILES

PLATE 2



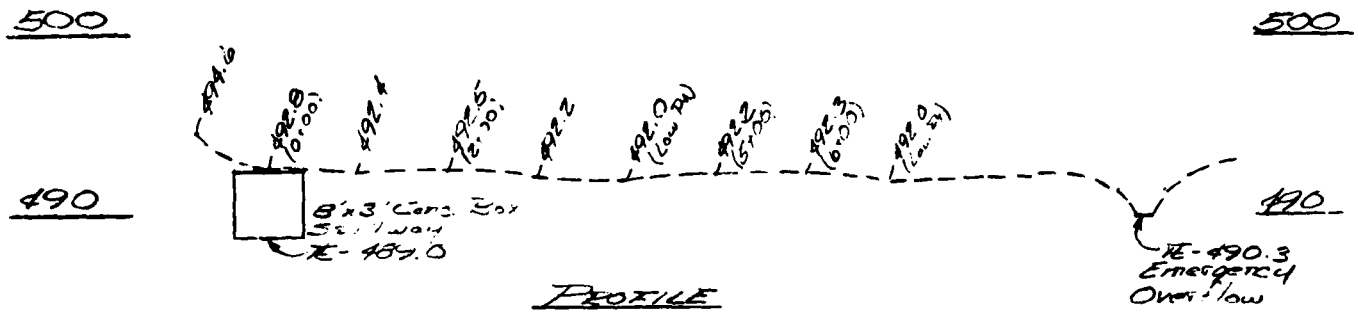
PLAN

LAKE HOLLENBECK

TOP OF DAM ELEVATIONS

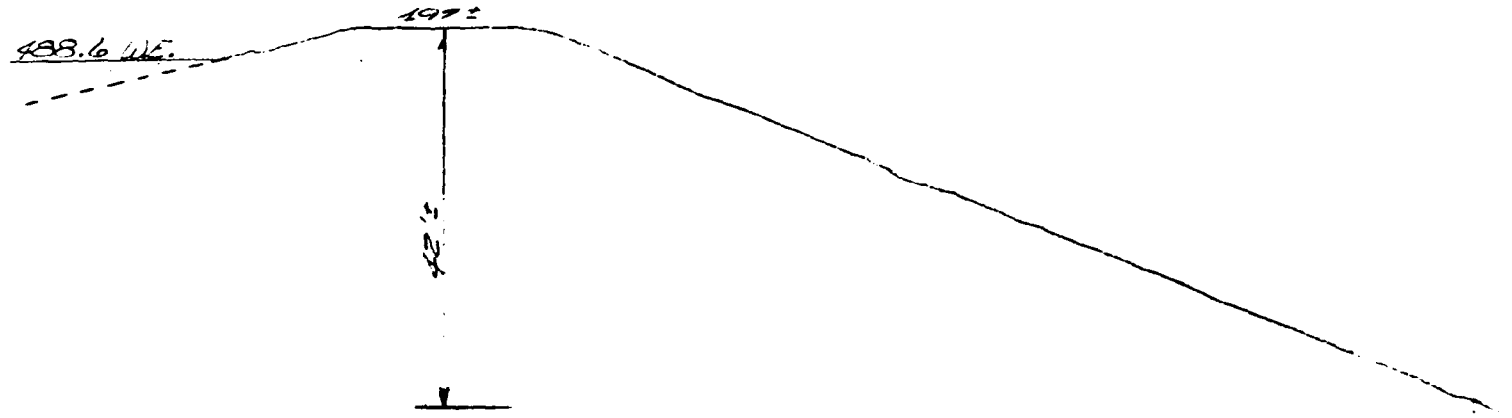
SCALE: 1"=100±

PLATE 3



PROFILE

SCALE: 1" = 200' H.
1" = 10' V.



TYPICAL CROSS SECTION

SCALE 1" = 20' HORIZ & VERT.

LAKE HOLLENBECK
DAM PROFILE
and CROSS SECTION

PLATE 4

PHOTO 1 Overview of Lake and Dam

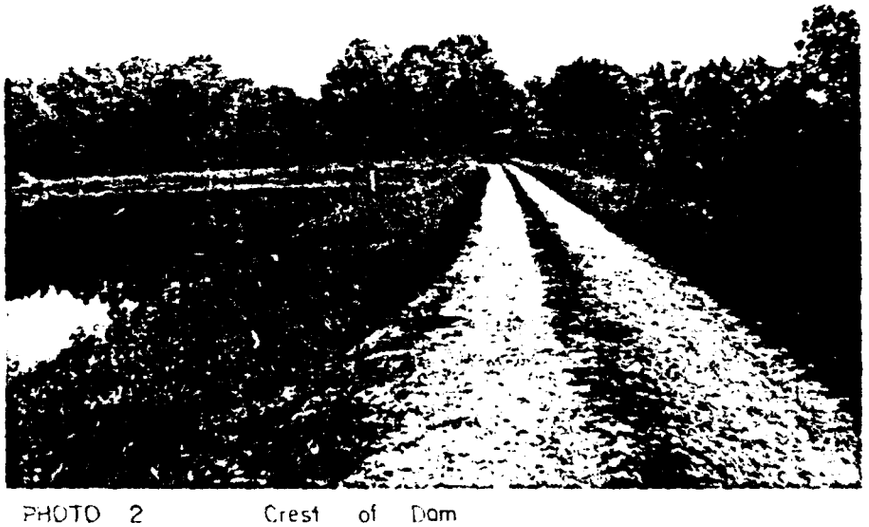


PHOTO 2 Crest of Dam

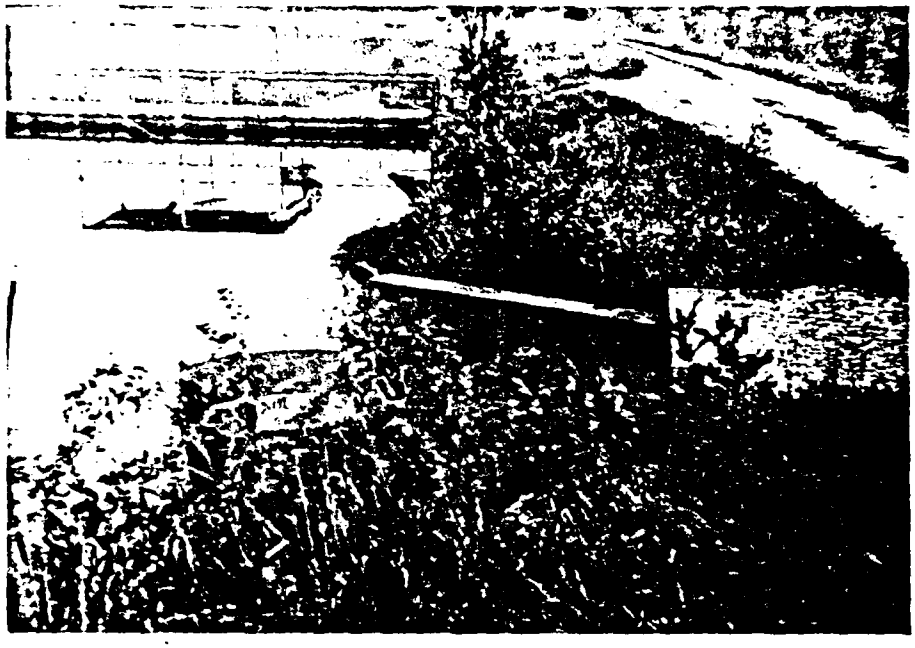


PHOTO 3 Principal Spillway Entrance

PHOTO 4 View Looking Upstream of Principal Spillway Exit

PHOTO 5 View of Emergency Spillway

PHOTO 6 Emergency Spillway Entrance

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODOLOGY

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODOLOGY

1. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 24-hour storm duration is assumed with the total rainfall depth distributed over 6-hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6-hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The nonpeak 6-hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by utilizing the Soil Conservation Service triangle unit hydrograph using Hydrologic Soils Group "B" and Antecedent Moisture Condition III and SCS CN 78 used to determine rainfall excess.

Lag time was estimated using methods outlined in "Design of Small Dams", by the United States Department of The Interior, Bureau of Reclamation. Using this source, lag time is taken as 60% of the time of concentration.

Time of concentration was estimated utilizing methods outlined in the source quoted above, supplemented by data obtained during field investigation. The results of the field investigation indicated that a minimum time of 20 minutes should prevail over a lesser value obtained using the methods outlined in the quoted source. For this lake, a lag time of 0.20 hours was therefore selected.

2. The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillway, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the outlet works, spillway, and top of dam are defined by elevation-discharge curves.

3. Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

4. The above methodology has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the attached computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.

5. The inflow hydrograph was routed through the reservoir using HEC-1's Modified Puls option. Releases were calculated for: 1) the concrete box culvert, and, 2) the overflow spillway, and 3) the flow over the top of the dam. These releases were then combined at each of their respective elevations.

Flow through the concrete box spillway was obtained by considering the culvert as a short tube. The Bernoulli equation was then written from the water surface in the lake to the energy gradient at the outlet. If the datum plane is taken at the pool water surface, then:

$$h_t = h_e + h_f$$

Where h_t = difference between the lake water surface and the energy gradient elevation at the outlet.

h_e = entrance loss, or $k_e \frac{V^2}{2g}$, where k_e varies between 0.5 and approximately 1.0.

h_f = friction loss through the culvert calculated by using Manning Formula.

Flow through the overflow spillway and over the top of dam was calculated using the weir flow equation:

$$Q = CL(H)^{1.5}$$

where: C = Varies with head as outlined in "Handbook of Hydraulics" by Horace Williams King, revised by Ernest F. Brater.

L = Length in feet (varies with water surface)

H = Head of water in feet (varies with water surface)

Q = Discharge in cfs

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  3 AUG 78
**********
    1              A1                                LAKE HOLLENBECK
    2              A2                                  NOV. 30, 1978
    3              A3                                MO. INV. NO. 40050
    4              B    288      -0       5       -0       -0       -0       -0       -0       -4       -0
    5              B1     5
    6              J      1        6       1
    7              J1   .25      .30     .35      .40      .50     1.00
    8              K      0 INFLOW                                    3
    9              M      1        2     .28                         1                                  1
   10              P               27     100      120      130
   11              T                                                          -1       -78                .05
   12              W2              .20
   13              X    .56      -.1       3
   14              K      1 ROUTING                                   2        2
   15              Y                                        1        1
   16              Y1     1                                                        -489.0       -1
   17              Y4 489.0    489.5    490.0    490.5    491.0    491.5    492.0    492.5    493.0    493.5
   18              Y4 494.0    494.5    495.0    495.5    496.0
   19              Y5     0     6.92    17.03    32.64    64.88   160.67   311.26   332.29  1269.51  2435.90
   20              Y54356.0  4421.75  8768.51 11355.4  14165.6
   21              $5     0     13.5    27.49    41.89    56.61    71.65    87.01   102.69   118.69   135.02
   22              $5151.67   168.64   185.93   203.54   221.47
   23              $E 489.0    489.5    490.0    490.5    491.0    491.5    492.0    492.5    493.0    493.5
   24              $E 494.0    494.5    495.0    495.5    496.0
   25              $$ 489.0
   26              $D 492.0
   27              K     99
```

COMPUTER INPUT DATA

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 3 AUG 78
****

RUN DATED 12/07/78.
TIME= 10.08.21.

INPUT UNIT HYDROGRAPH

LAKE HOLLENBECK
NOV. 30, 1978
MO. INV. NO. 40050

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	-0	5	-0	-0	-0	-0	-0	-4	-0

JOPER	NWT	LROPT	TRACE
5	-0	-0	-0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1
RTIOS= .25 .30 .35 .40 .50 1.00

****

SUB-AREA RUNOFF COMPUTATION

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
NFLOW	0	-0	-0	-0	3	-0	-0	-0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.28	-0.00	.28	1.00	-0.000	-0	1	-0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
-0.00	27.00	100.00	120.00	130.00	-0.00	-0.00	-0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
-0	-0.00	-0.00	1.00	-0.00	-0.00	1.00	-1.00	-78.00	-0.00	.05

CURVE NO = -78.00 WETNESS = -1.00 EFFECT CN = 78.00

UNIT HYDROGRAPH DATA
TC= -0.00 LAG= .20

RECESSION DATA
STRTQ= .56 QRCSN= -.10 RTIOR= 3.00

UNIT HYDROGRAPH 14 END OF PERIOD ORDINATES, TC= -0.00 HOURS, LAG= .20 VOL= 1.00

136.	450.	558.	446.	248.	143.	81.	47.	26.	15.
9.	5.	3.	1.						

END-OF-PERIOD FLOW

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	1.	1.01	12.05	145	.22	.20	.02	164.
						1.	1.01	12.10	146	.22	.20	.02	225.

1.01	.25	5	.01	.00	.01	2.	1.01	12.25	154	.22	.21	.02	399.
1.01	.30	6	.01	.00	.01	2.	1.01	12.30	150	.22	.21	.02	420.
1.01	.35	7	.01	.00	.01	2.	1.01	12.35	151	.22	.21	.02	433.
1.01	.40	8	.01	.00	.01	2.	1.01	12.40	152	.22	.21	.02	441.
1.01	.45	9	.01	.00	.01	2.	1.01	12.45	153	.22	.21	.01	446.
1.01	.50	10	.01	.00	.01	2.	1.01	12.50	154	.22	.21	.01	450.
1.01	.55	11	.01	.00	.01	2.	1.01	12.55	155	.22	.21	.01	453.
1.01	1.00	12	.01	.00	.01	2.	1.01	13.00	156	.22	.21	.01	455.
1.01	1.05	13	.01	.00	.01	2.	1.01	13.05	157	.27	.25	.02	462.
1.01	1.10	14	.01	.00	.01	2.	1.01	13.10	158	.27	.26	.01	483.
1.01	1.15	15	.01	.00	.01	2.	1.01	13.15	159	.27	.26	.01	508.
1.01	1.20	16	.01	.00	.01	2.	1.01	13.20	160	.27	.26	.01	528.
1.01	1.25	17	.01	.00	.01	2.	1.01	13.25	161	.27	.26	.01	540.
1.01	1.30	18	.01	.00	.01	2.	1.01	13.30	162	.27	.26	.01	547.
1.01	1.35	19	.01	.00	.01	2.	1.01	13.35	163	.27	.26	.01	552.
1.01	1.40	20	.01	.00	.01	2.	1.01	13.40	164	.27	.26	.01	555.
1.01	1.45	21	.01	.00	.01	2.	1.01	13.45	165	.27	.26	.01	557.
1.01	1.50	22	.01	.00	.01	2.	1.01	13.50	166	.27	.26	.01	559.
1.01	1.55	23	.01	.00	.01	2.	1.01	13.55	167	.27	.26	.01	560.
1.01	2.00	24	.01	.00	.01	2.	1.01	14.00	168	.27	.26	.01	562.
1.01	2.05	25	.01	.00	.01	2.	1.01	14.05	169	.34	.33	.01	572.
1.01	2.10	26	.01	.00	.01	2.	1.01	14.10	170	.34	.33	.01	602.
1.01	2.15	27	.01	.00	.01	2.	1.01	14.15	171	.34	.33	.01	639.
1.01	2.20	28	.01	.00	.01	2.	1.01	14.20	172	.34	.33	.01	669.
1.01	2.25	29	.01	.00	.01	2.	1.01	14.25	173	.34	.33	.01	686.
1.01	2.30	30	.01	.00	.01	2.	1.01	14.30	174	.34	.33	.01	697.
1.01	2.35	31	.01	.00	.01	2.	1.01	14.35	175	.34	.33	.01	703.
1.01	2.40	32	.01	.00	.01	2.	1.01	14.40	176	.34	.33	.01	707.
1.01	2.45	33	.01	.00	.01	2.	1.01	14.45	177	.34	.33	.01	709.
1.01	2.50	34	.01	.00	.01	2.	1.01	14.50	178	.34	.33	.01	711.
1.01	2.55	35	.01	.00	.01	2.	1.01	14.55	179	.34	.33	.01	712.
1.01	3.00	36	.01	.00	.01	2.	1.01	15.00	180	.34	.33	.01	713.
1.01	3.05	37	.01	.00	.01	2.	1.01	15.05	181	.21	.20	.00	695.
1.01	3.10	38	.01	.00	.01	2.	1.01	15.10	182	.41	.40	.01	666.
1.01	3.15	39	.01	.00	.01	2.	1.01	15.15	183	.41	.40	.01	685.
1.01	3.20	40	.01	.00	.01	2.	1.01	15.20	184	.62	.60	.01	767.
1.01	3.25	41	.01	.00	.01	2.	1.01	15.25	185	.72	.71	.01	930.
1.01	3.30	42	.01	.00	.01	2.	1.01	15.30	186	1.74	1.72	.03	1258.
1.01	3.35	43	.01	.00	.01	2.	1.01	15.35	187	2.87	2.84	.04	2030.
1.01	3.40	44	.01	.00	.01	3.	1.01	15.40	188	1.13	1.12	.01	2969.
1.01	3.45	45	.01	.00	.01	3.	1.01	15.45	189	.72	.71	.01	3275.
1.01	3.50	46	.01	.00	.01	3.	1.01	15.50	190	.62	.61	.01	2904.
1.01	3.55	47	.01	.00	.01	4.	1.01	15.55	191	.41	.41	.00	2279.
1.01	4.00	48	.01	.00	.01	4.	1.01	16.00	192	.41	.41	.00	1776.
1.01	4.05	49	.01	.00	.01	4.	1.01	16.05	193	.31	.31	.00	1403.
1.01	4.10	50	.01	.00	.01	4.	1.01	16.10	194	.31	.31	.00	1131.
1.01	4.15	51	.01	.00	.01	5.	1.01	16.15	195	.31	.31	.00	947.
1.01	4.20	52	.01	.00	.01	5.	1.01	16.20	196	.31	.31	.00	83[illegible]
1.01	4.25	53	.01	.00	.01	5.	1.01	16.25	197	.31	.31	.00	765.
1.01	4.30	54	.01	.00	.01	6.	1.01	16.30	198	.31	.31	.00	727.
1.01	4.35	55	.01	.00	.01	6.	1.01	16.35	199	.31	.31	.00	705.
1.01	4.40	56	.01	.00	.01	6.	1.01	16.40	200	.31	.31	.00	690.
1.01	4.45	57	.01	.00	.01	6.	1.01	16.45	201	.31	.31	.00	683.
1.01	4.50	58	.01	.00	.01	7.	1.01	16.50	202	.31	.31	.00	680.
1.01	4.55	59	.01	.00	.01	7.	1.01	16.55	203	.31	.31	.00	678.
1.01	5.00	60	.01	.00	.01	7.	1.01	17.00	204	.31	.31	.00	678.
1.01	5.05	61	.01	.00	.01	7.	1.01	17.05	205	.25	.25	.00	669.
1.01	5.10	62	.01	.00	.01	8.	1.01	17.10	206	.25	.25	.00	638.
1.01	5.15	63	.01	.00	.01	8.	1.01	17.15	207	.25	.25	.00	601.
1.01	5.20	64	.01	.00	.01	8.	1.01	17.20	208	.25	.25	.00	571.
1.01	5.25	65	.01	.00	.01	8.	1.01	17.25	209	.25	.25	.00	555.
1.01	5.30	66	.01	.00	.01	8.	1.01	17.30	210	.25	.25	.00	545.
1.01	5.35	67	.01	.00	.01	9.	1.01	17.35	211	.25	.25	.00	540.
1.01	5.40	68	.01	.00	.01	9.	1.01	17.40	212	.25	.25	.00	537.
1.01	5.45	69	.01	.00	.01	9.	1.01	17.45	213	.25	.25	.00	535.

SYSTEMS, INC.

INPUT UNIT HYDROGRAPH

1.01	5.55	71	.01	.00	.01	10.	1.01	17.55	215	.25	.25	.00	544.
1.01	5.60	72	.01	.00	.01	10.	1.01	18.00	216	.25	.25	.00	533.
1.01	6.05	73	.07	.03	.05	13.	1.01	18.05	217	.02	.02	.00	503.
1.01	6.10	74	.07	.03	.05	22.	1.01	18.10	218	.02	.02	.00	402.
1.01	6.15	75	.07	.03	.05	35.	1.01	18.15	219	.02	.02	.00	314.
1.01	6.20	76	.07	.03	.04	47.	1.01	18.20	220	.02	.02	.00	281.
1.01	6.25	77	.07	.03	.04	55.	1.01	18.25	221	.02	.02	.00	252.
1.01	6.30	78	.07	.03	.04	61.	1.01	18.30	222	.02	.02	.00	226.
1.01	6.35	79	.07	.04	.04	67.	1.01	18.35	223	.02	.02	.00	202.
1.01	6.40	80	.07	.04	.04	71.	1.01	18.40	224	.02	.02	.00	181.
1.01	6.45	81	.07	.04	.04	75.	1.01	18.45	225	.02	.02	.00	162.
1.01	6.50	82	.07	.04	.03	79.	1.01	18.50	226	.02	.02	.00	145.
1.01	6.55	83	.07	.04	.03	82.	1.01	18.55	227	.02	.02	.00	130.
1.01	7.00	84	.07	.04	.03	85.	1.01	19.00	228	.02	.02	.00	117.
1.01	7.05	85	.07	.04	.03	88.	1.01	19.05	229	.02	.02	.00	105.
1.01	7.10	86	.07	.05	.03	91.	1.01	19.10	230	.02	.02	.00	94.
1.01	7.15	87	.07	.05	.03	93.	1.01	19.15	231	.02	.02	.00	84.
1.01	7.20	88	.07	.05	.03	96.	1.01	19.20	232	.02	.02	.00	75.
1.01	7.25	89	.07	.05	.03	98.	1.01	19.25	233	.02	.02	.00	67.
1.01	7.30	90	.07	.05	.03	100.	1.01	19.30	234	.02	.02	.00	60.
1.01	7.35	91	.07	.05	.03	102.	1.01	19.35	235	.02	.02	.00	54.
1.01	7.40	92	.07	.05	.02	104.	1.01	19.40	236	.02	.02	.00	48.
1.01	7.45	93	.07	.05	.02	106.	1.01	19.45	237	.02	.02	.00	48.
1.01	7.50	94	.07	.05	.02	108.	1.01	19.50	238	.02	.02	.00	48.
1.01	7.55	95	.07	.05	.02	109.	1.01	19.55	239	.02	.02	.00	48.
1.01	8.00	96	.07	.05	.02	111.	1.01	20.00	240	.02	.02	.00	48.
1.01	8.05	97	.07	.05	.02	113.	1.01	20.05	241	.02	.02	.00	48.
1.01	8.10	98	.07	.05	.02	114.	1.01	20.10	242	.02	.02	.00	44.
1.01	8.15	99	.07	.06	.02	116.	1.01	20.15	243	.02	.02	.00	48.
1.01	8.20	100	.07	.06	.02	117.	1.01	20.20	244	.02	.02	.00	48.
1.01	8.25	101	.07	.06	.02	118.	1.01	20.25	245	.02	.02	.00	48.
1.01	8.30	102	.07	.06	.02	119.	1.01	20.30	246	.02	.02	.00	48.
1.01	8.35	103	.07	.06	.02	121.	1.01	20.35	247	.02	.02	.00	48.
1.01	8.40	104	.07	.06	.02	122.	1.01	20.40	248	.02	.02	.00	48.
1.01	8.45	105	.07	.06	.02	123.	1.01	20.45	249	.02	.02	.00	48.
1.01	8.50	106	.07	.06	.02	124.	1.01	20.50	250	.02	.02	.00	48.
1.01	8.55	107	.07	.06	.02	125.	1.01	20.55	251	.02	.02	.00	48.
1.01	9.00	108	.07	.06	.02	126.	1.01	21.00	252	.02	.02	.00	48.
1.01	9.05	109	.07	.06	.02	127.	1.01	21.05	253	.02	.02	.00	44.
1.01	9.10	110	.07	.06	.01	128.	1.01	21.10	254	.02	.02	.00	48.
1.01	9.15	111	.07	.06	.01	129.	1.01	21.15	255	.02	.02	.00	48.
1.01	9.20	112	.07	.06	.01	129.	1.01	21.20	256	.02	.02	.00	48.
1.01	9.25	113	.07	.06	.01	130.	1.01	21.25	257	.02	.02	.00	48.
1.01	9.30	114	.07	.06	.01	131.	1.01	21.30	258	.02	.02	.00	48.
1.01	9.35	115	.07	.06	.01	132.	1.01	21.35	259	.02	.02	.00	48.
1.01	9.40	116	.07	.06	.01	132.	1.01	21.40	260	.02	.02	.00	48.
1.01	9.45	117	.07	.06	.01	133.	1.01	21.45	261	.02	.02	.00	48.
1.01	9.50	118	.07	.06	.01	134.	1.01	21.50	262	.02	.02	.00	48.
1.01	9.55	119	.07	.06	.01	134.	1.01	21.55	263	.02	.02	.00	48.
1.01	10.00	120	.07	.06	.01	135.	1.01	22.00	264	.02	.02	.00	48.
1.01	10.05	121	.07	.06	.01	136.	1.01	22.05	265	.02	.02	.00	48.
1.01	10.10	122	.07	.06	.01	136.	1.01	22.10	266	.02	.02	.00	48.
1.01	10.15	123	.07	.06	.01	137.	1.01	22.15	267	.02	.02	.00	48.
1.01	10.20	124	.07	.06	.01	137.	1.01	22.20	268	.02	.02	.00	48.
1.01	10.25	125	.07	.06	.01	138.	1.01	22.25	269	.02	.02	.00	48.
1.01	10.30	126	.07	.06	.01	138.	1.01	22.30	270	.02	.02	.00	48.
1.01	10.35	127	.07	.06	.01	139.	1.01	22.35	271	.02	.02	.00	48.
1.01	10.40	128	.07	.06	.01	139.	1.01	22.40	272	.02	.02	.00	48.
1.01	10.45	129	.07	.07	.01	140.	1.01	22.45	273	.02	.02	.00	48.
1.01	10.50	130	.07	.07	.01	140.	1.01	22.50	274	.02	.02	.00	48.
1.01	10.55	131	.07	.07	.01	141.	1.01	22.55	275	.02	.02	.00	48.
1.01	11.00	132	.07	.07	.01	141.	1.01	23.00	276	.02	.02	.00	48.
1.01	11.05	133	.07	.07	.01	142.	1.01	23.05	277	.02	.02	.00	48.
1.01	11.10	134	.07	.07	.01	142.	1.01	23.10	278	.02	.02	.00	48.
1.01	11.15	135	.07	.07	.01	143.	1.01	23.15	279	.02	.02	.00	48.

SYSTEMS, INC

INPUT UNIT HYDROGRAPH

1.01	11.25	137	.07	.07	.01	144.	1.01	23.25	281	.02	.02	.00	48.
1.01	11.30	138	.07	.07	.01	144.	1.01	23.30	282	.02	.02	.00	48.
1.01	11.35	139	.07	.07	.01	144.	1.01	23.35	283	.02	.02	.00	48.
1.01	11.40	140	.07	.07	.01	144.	1.01	23.40	284	.02	.02	.00	48.
1.01	11.45	141	.07	.07	.01	145.	1.01	23.45	285	.02	.02	.00	48.
1.01	11.50	142	.07	.07	.01	145.	1.01	23.50	286	.02	.02	.00	48.
1.01	11.55	143	.07	.07	.01	145.	1.01	23.55	287	.02	.02	.00	48.
1.01	12.00	144	.07	.07	.01	145.	1.02	0.00	288	.02	.02	.00	48.
								SUM	35.10	32.09	3.01	70596.
									(892.)	(815.)	(77.)	(1999.06)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3275.	785.	245.	245.	70587.
CMS	93.	22.	7.	7.	1999.
INCHES		26.10	32.57	32.57	32.57
MM		662.82	827.29	827.29	827.29
AC-FT		389.	486.	486.	486.
THOUS CU M		480.	600.	600.	600.

HYDROGRAPH AT STANFLOW FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	819.	196.	61.	61.	17647.
CMS	23.	6.	2.	2.	500.
INCHES		6.52	8.14	8.14	8.14
MM		165.71	206.82	206.82	206.82
AC-FT		97.	122.	122.	122.
THOUS CU M		120.	150.	150.	150.

HYDROGRAPH AT STANFLOW FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	983.	236.	74.	74.	21176.
CMS	28.	7.	2.	2.	600.
INCHES		7.83	9.77	9.77	9.77
MM		198.85	248.19	248.19	248.19
AC-FT		117.	146.	146.	146.
THOUS CU M		144.	180.	180.	180.

HYDROGRAPH AT STANFLOW FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1146.	275.	86.	86.	24705.
CMS	32.	8.	2.	2.	700.
INCHES		9.13	11.40	11.40	11.40
MM		231.99	289.55	289.55	289.55
AC-FT		136.	170.	170.	170.
THOUS CU M		168.	210.	210.	210.

HYDROGRAPH AT STANFLOW FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1310.	314.	98.	98.	28235.
CMS	37.	9.	3.	3.	800.
INCHES		10.44	13.03	13.03	13.03
MM		265.13	330.92	330.92	330.92

INPUT UNIT HYDROGRAPH

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	489.00	489.00	492.00
STORAGE	0.	0.	87.
OUTFLOW	0.	0.	311.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	491.57	0.00	74.	181.	0.00	16.50	0.00
.30	491.69	0.00	84.	278.	0.00	16.25	0.00
.35	492.22	.22	94.	321.	1.50	16.25	0.00
.40	492.54	.54	104.	408.	2.67	16.25	0.00
.50	492.81	.81	113.	907.	3.25	16.00	0.00
1.00	493.55	1.55	137.	2625.	5.83	15.83	0.00

COMPUTER SUMMARY ANALYSIS

[illegible] SYSTEMS, INC.